

TED07 – (Part E12) Further Water and Soil for HL

Name _____

1. E.12.1 Solve problems relating to the removal of heavy-metal ions, phosphates and nitrates from water by chemical precipitation. (3)

Given the equilibrium formed by a metal M and a non-metal X: $MX(s) \rightleftharpoons M^+(aq) + X^-(aq)$.

The K_{eq} for this system is given by $K_{sp} = [M^+][X^-]$, and is called the solubility product constant.

Students should be able to solve problems associated with this type of equilibrium, including the common ion effect.

- How does the addition of another compound effect the solubility in water?
- How does temperature effect the solubility of a solid or gas in solution?
- For a partially soluble salt, the following equilibrium is used ($MX(s) \rightleftharpoons M^+(aq) + X^-(aq)$) provide the equilibrium expression, K_c :
- Now rearrange to solve for K_{sp} , the solubility constant:
- For a complex metal such as $Al(OH)_3$ provide the K_{sp} :
- Calculating K_{sp} from solubility:
 - Solubility of lead (II) bromide at 298K is $6.15 \frac{g}{dm^3}$,
- Calculating solubility from K_{sp}
 - $K_{sp} [Al(OH)_3] = 1.0 \times 10^{-32}$
- What is the common ion effect?
- Calculate the common ion effect when AgCl is dissolved in a solution of NaCl:
 - First, determine the molarity of AgCl dissolved in water: (for AgCl $K_{sp} = 2.0 \times 10^{-10}$ at 298K, dissolved in H_2O)
 - Now, if the same salt is dissolved in $NaCl(s) \rightleftharpoons Na^+(aq) + Cl^-(aq)$ (solution is 0.1M) find the molarity of AgCl in the solution:

2. E.12.2 State what is meant by the term cation-exchange capacity (CEC) and outline its importance. (2)
The amount of exchangeable cations in a clay is called cation-exchange capacity. Include equations as appropriate.
- a. What is the cation exchange capacity (CEC)?
3. E.12.3 Discuss the effects of soil pH on cation-exchange capacity and availability of nutrients. (3)
Examples of nutrients include Ca, Mg, Fe, Al, P, N, S, Cu and Zn. Use equations as appropriate.
- a. What happens to the solubility of cations when acids are added to soils?
- i. Provide an equation using Mg^{2+} as your example:
- b. What happens to the solubility of anions when acids are added to soils?
- i. Provide an equation using OH^- and HNO_3 :
4. E.12.4 Describe the chemical functions of soil organic matter (SOM). (2) *Include the following:*
Contributes to cation-exchange capacity
Enhances the ability of soil to buffer changes in pH
Binds to organic and inorganic compounds in soil
Reduces the negative environmental effects of pesticides, heavy metals and other pollutants by binding contaminants
Forms stable complexes with cations